Appendix 9

Vegetated Roof Design Specification Example

Designers: Boxwood of Seattle, WA and Roofscapes Inc., Philadelphia, PA.

Roof location: Point Defiance Zoo animal health care facility, Tacoma. WA.

The specification that follows is provided by Boxwood of Seattle and Roofscapes, Inc., and was used in the construction of this vegetated roof.

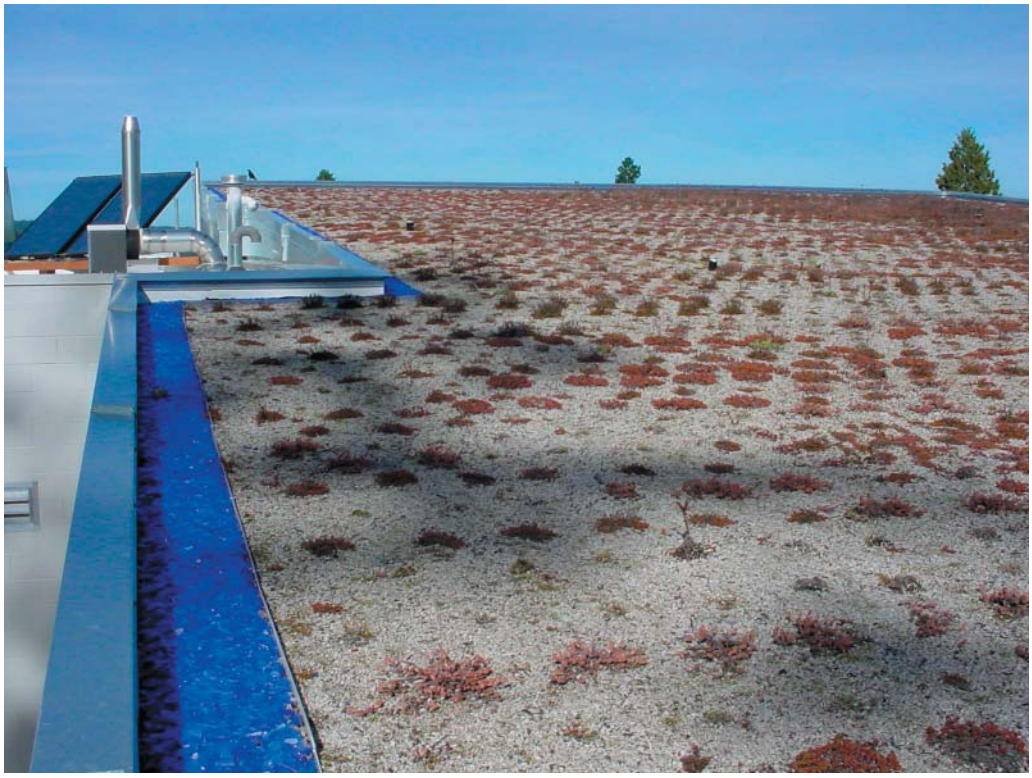

Figure 1 Vegetated roof at Point Defiance Zoo animal health care facility. *Photo by Curtis Hinman*

Summary

- The vegetated cover is a two-layer system, consisting of a 2.5-inch growth media layer installed over the Meadowflor™ drainage system. The weight of this system at Maximum Water Capacity and with rainfall runoff occurring is less than or equal to 15 pounds per square foot.
- The system is not irrigated. However, it may require periodic hand watering during the initial 12 months of the establishment period.

Thermoplastic Sheet Waterproofing Membrane

- Materials:
  - Sarnafil G476 fiberglass reinforced membrane and compatible sealant.
  - Minimum thickness: 60 mils.
  - All roofing components should be compatible with the membrane.
- Quality Assurance:
  - Only an approved contractor authorized by the manufacturer prior to bid should apply the waterproofing system.
  - Installation of waterproofing membrane, flashing, membrane expansion joints, membrane containment grids, membrane protection layers, drainage layer and insulation should be the responsibility of the membrane applicator to ensure undivided responsibility.
  - Obtain primary waterproofing materials, membrane, and flashing from a single manufacturer with not less than 10 years of successful experience in waterproofing applications. Provide other system components only as approved by manufacturer of primary materials.
  - Waterproofing contractor should arrange with the membrane manufacturer to have the services of a competent field representative at the site to accept the substrate surface before installation of waterproofing materials. The field representative of the membrane manufacturer should check and test all heat-welded seams before the water test, and prior to installation of separation and protection layers.
  - Before construction begins the owner, architect, contractor's field superintendent, waterproofing foreman, waterproofing membrane manufacturer's field representative, and other involved trades should meet to discuss waterproofing practices applicable to this project.
  - There should be no deviation made from the contract specification or the approved shop drawings without prior written approval by the owner, the owner's representative and/or design professional, and membrane manufacturer.
  - Water testing of the completed waterproofing system should be for a minimum of 24 hours. Water testing should be witnessed and confirmed in writing by the owner's representative and/or design professional, the waterproofing contractor, and membrane manufacturer.
  - Trained and authorized personnel should complete all work.
- Installation
  - The surface substrate should be clean, dry, free from debris, and smooth with no surface roughness or contamination. Broken, delaminated, wet or damaged insulation or recover boards should be removed and replaced.
  - Overlap rolls by 3 inches. Shingle seam overlaps with the flow of draining rainwater when possible.
  - Hot-air welding of seam overlaps:
    - ✓ Seams should be 3-inch when using an automatic machine welding, and 4-inch when hand welding.
    - ✓ All membrane to be welded should be clean and dry. Follow manufacturer's specifications for welding.
  - Flashings: all flashings should be installed concurrently with the waterproofing membrane as the job progresses per manufacturer's directions. No temporary flashings will be allowed. All flashings should be inspected and accepted by the membrane manufacturer.
  - Temporary cut off: when a break in the day's work occurs, install a temporary watertight seal by sealing the membrane to the deck or substrate. When work resumes, the contaminated membrane should be removed. If any water is allowed to enter under the completed waterproofing, the affected area should be removed and replaced at the contractor's expense.
  - Membrane is incompatible with asphalt, oil-based and plastic-based cements, creosote and penta-based materials. If contact occurs, the material should be cut out and discarded. The

contractor should consult the manufacturer with respect to material compatibility, precautions, and recommendations.

- o Contaminants, such as grease, fats, oils, and solvents, should not be allowed to come into direct contact with the waterproofing membrane.

Protection Fabric

- Material: 22-ounce per square yard polypropylene non-woven needled geotextile.
- The surface of the waterproofing system should be swept and washed.
- Until the drain sheet is installed, traffic over the working area should be strictly controlled and limited to essential personnel only.
- Heavily traveled areas (e.g., corridors for transporting material to the working areas) must be protected in a manner approved by the waterproofing installer.
- Suitably protect lay-down areas using ½-inch plywood over 1-inch sheets of expanded polystyrene, or similar sheathing material.
- Roll out the protection fabric on top of the completed waterproofing system.
- Overlap seams a minimum of 6 inches and tack seams using a hot-air welding gun (Leister, or equivalent).

MEADOWFLOR™ Drainage System

- The vegetated cover system should be underlain everywhere by the Meadowflor™ system. This consists of:
  - o Roofmeadow® perforated polyethylene drain sheet with adhered polypropylene separation fabric. The sheet is a dimpled sheet. The composite system satisfies the following specifications:

Membrane thickness	≥ 20 mil
Compressive strength	≥ 5,200 lb/ft^2
Tensile strength (ASTM-D4594)	≥ 1,000 lb/ft
Brittleness temperature (ASTM-D746)	≤ -50^o F
Softening temperature	≥ 250^o F
Transmissivity (between platens)	≥ 24 gal/min/ft
Permittivity (ASTM-D4491)	≥1.5 sec^{-1}
Height (varies according to position)	0.39 to 0.78 in

  - o Separation Fabric
    - ✓ Needled non-woven polypropylene geotextile fabric. This component should satisfy the following specifications:

Unit Weight (ASTM-D5261)	≥ 4.25 oz/yd^2
Puncture Resistance (ASTM-D4833)	≥ 35 lbs
Mullen Burst Strength (ASTM-D4632)	≥ 135 lb/in
Permittivity (ASTM-D4491)	≥ 1.5 sec^{-1}

- Install the drain sheet, together with separation sheet. The drain sheet should be installed with the studs and fabric layer facing up to enhance rapid drainage of the overlying media.
- Assemble the perforated conduit on top of the drain sheet, as shown on the drawings.
- Weigh down the drainage layer with temporary ballast, as necessary.

Border Elements

- Roofmeadow® cantilever, fabricated from 1/8-inch aluminum.
- Height: ≥ 0.25 inch higher than the top of the growth media layer.
- Base Length: 7 inches, or 1.5 times the height of the element, whichever is greater.
- Install border elements as required to prevent mixing of ballast and growth media.

Growth Media Layer

- Roofmeadow® Type M1 Extensive Growth Media. This material is a mixture of mineral and organic components that satisfies the following specifications:
  - o Void ratio at Field Capacity (0.333 bar) ≥ 15% (vol)
  - o Moisture content at Field Capacity ≥ 10% (vol)
  - o Maximum Water Capacity ≥ 20% (vol)
  - o Density at Maximum Water Capacity ≤ 62 lb/ft^3
  - o Saturated Hydraulic Conductivity ≥ 1.5 in/hr, and ≤ 15.0 in/hr
  - o Volatile fraction (organic matter) ≤ 10% (dry wt.)
  - o pH 5.5 - 7.9
  - o Soluble salts ≤ 0.30 mmhos/cm (1:20 dilution)
  - o Grain-size distribution of the mineral fraction (ASTM-D422)

Clay fraction (2 micron)	≤ 1%
Pct. Passing US#200sieve	≤ 5% (i.e., silt fraction)
Pct. Passing US#60 sieve	≤ 10%
Pct. Passing US#18 sieve	5 - 50%
Pct. Passing 1/8-inch sieve	20 - 70%
Pct. Passing 3/8-inch sieve	75 -100%

- Macro and micronutrients should be incorporated in the formulation in initial proportions suitable to support the specified planting.
- Thoroughly blend at a batch facility. Moisten, as required, to prevent separation and loss of fine particles during installation.
- Quality control samples should be collected and submitted for testing for each 100 CY provided to the job.
- Placing the growth media layer: The media should be dispensed at the roof level in a manner that will not suddenly increase the load to the roof. It should be immediately spread to the specified thickness, plus 10 percent (after moderate compaction).
- Set the media back from the curbs and parapets as directed in the specifications. The set back for this project is 12 inches. At the margins of the media spread a 2-foot wide strip of separation fabric.
- Cover the media layer with the wind blanket and secure, unless direct seeding (see below).
- Thoroughly soak with water using a sprinkler or hand sprayer. For a 4-inch growth media layer, expect to use about 30 gallons per 100 square feet.

Gravel Margin

- Fill the area between the flashed wall and growth media with gravel as specified.

Planting (plug installation)

- The following plant list should be installed. Any alternatives must be approved by the green roof installer.
- All extensive planting schemes must incorporate *Sedum* species. *Sedum* must represent at least 50 percent of the installed plants. Additionally, the plant mixture should include a minimum of four different species of *Sedum* in approximately equal quantities.
- Non-*Sedum* varieties should be selected that are adapted to the specific growing conditions.
- Plant installation should occur May-June or September-October, unless an active irrigation system is included.
- Plants should be established from 32-cell plugs propagated in sterile nursery medium, according to the plant provider's recommendations. Plugs larger than this can be used; however, the establishment rate is typically better with the smaller plants. The recommended minimum planting rate is 640 plants per 1000 square feet.
- Thoroughly soak the growth media prior to planting.
- The plugs should be set into the media to their full depth and the media pressed firmly around the installed plug. At the end of each day, soak those areas that have been newly planted.
- Do not mulch.

Plant List:

Allium schoenprasm

Delopserma nubigenum

D. cooperii

Echeveria sp.

Petrohagia saxifraga

Sedum floriferum

S. album

S. sexangulare

S. spurium roseum

S. pinofolium

S. reflexum

S. sarmentosum

S. boehmii (orostachys)

Sempervivum sp.

Wind Blanket

- Roofmeadow® photo/bio-degradable covering is used to protect the media from wind erosion during the 24-month plant establishment period. The provider must demonstrate that the wind blanket will remain securely in place during high winds and that it will not interfere with the growth of the plants. It must satisfy the following specifications:
  - o Aperture ≥ 0.04 in, and ≤ 0.125 inch
  - o Tensile strength (ASTM D4632) ≥ 20 lb
  - o Satisfies smolder resistance criteria (FTMA-CCC-%-191B)
- The Roofmeadow® Wind Blanket includes a method for firmly securing the protective layer to the green roof system.